FIRE MANAGEMENT

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FIRE MANAGEMENT

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Rappelling Stories Told

Two men, each in a different country, had the same problem: delivery of firefighters to dangerous areas. How did they solve it? With the same solution. Read *Helicopter Rappel Deployment Pays Off* (***cover story***), p. 3, and *Rappelling, an Alternative*, p. 5.

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Helicopter Rappel Deployment Technique Pays Off

Robert C. Henderson, H. G. Mayson, and A. J. Larsen

Near Revelstoke, B. C., during August of 1972, a helicopter transported men and equipment to the precise locations of four fires burning on lands administered by Canadian Cellulose Ltd. By a rappel device the crews and cargo were lowered from a helicopter hovering up to 250 feet above the ground.

The rappel system, which has Ministry of Transport approval, extends the present use of helicopters by specially trained forest fire suppression crews.

The rappel deployment technique works very well as an initial attack tool in rugged and remote terrain such as that which characterizes much of the northwestern forested region of North America. Initial attack times, helicopter flight times, and total suppression times on the fires which employed this technique were substantially reduced, and in one instance firefighters contained a fire just as it was beginning to make a run.

Rappel to Where the Action Is

Rapid initial attack using helicopter transportation can prevent many fires which start in forested areas from becoming large enough to do extensive damage. Helicopters are also used to deploy helispot construction crews into remote places. But the frustrating fact remains that the nearest safe landing spot is often miles from the site of a fire or from the desired location.

The technique employed near Revelstoke is similar to a mountain climber's rappel and uses a friction device, called Sky Genie, to control rate of descent. The Bell 206 (Jet Ranger) Series is at present the only kind of aircraft certified for this system in Canada.

All personnel must undergo strictly regulated training in each aspect of the technique and all equipment is inspected by the appropriate authority. The flight crew consists of a pilot,

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The personnel deployment system referred to above was developed by a project directed by R. C. Henderson, Faculty of Forestry, University of British Columbia and conducted by the University, Okanagan Helicopters Ltd., and International Forest Fire Systems Ltd. in cooperation with Canadian Cellulose Company Ltd. Ministry of Transport approval for an operational evaluation has been granted under the regulations of the Operations Manual. Henderson, Robert C. Operations Manual: Personnel Deployment System (206 U.B.C.) Oct. 1972 (Rev.) Univ. B. C.

Three men and their equipment can be deployed with precision from a height of up to 250 feet above the ground. (Vancouver Sun photo.)

a spotter, and up to three crewmen. The spotter acts as crew chief during the deployment procedure, maintaining constant intercom communication with the pilot and communicating with the crew by means of hand signals.

System Is Practical

Operational evaluation[1] of this rappelling technique on the four fires mentioned above shows that it compared favorably to the conventional methods of transporting fire control personnel:

The deployment system proved to be completely feasible and satisfactory to both flight crew members and helicopter pilots during all operations. Equipment used in the procedure performed well.

The technique appears to be considerably less expensive than the conventional method: on comparable fires, suppression costs that average $1,500-2,000 were reduced to a total cost of $500-800 when fires could be reached by means of rappel deployment.

This technique is also less hazardous than many woods operations, when carried out under the strict supervision outlined in the operations manual.

Initial attack time was reduced by a minimum of 3 hours as a result of the walking time saved by this precedure. The ground attack method often requires aircraft to lead in ground crews or indicate the direction to the site of the fire. In some cases crewmen are unable to locate the fire their first time out.

Average deployment time, including fire reconnaissance and deployment site location, took approximately 5 minutes upon arrival at the fire area. In one case action was taken at least 8 hours earlier than would otherwise have been possible since the helicopter was able to depart, deploy, and return all shortly before dark.

In addition, helicopter flight time was substantially reduced, regardless of how far from a helispot the fire was. In several cases flight time was cut by nearly 50 percent compared to that required by the conventional method. (A first-hand reconnaissance of every fire is built into the procedure of the rappel technique, whereas during conventional action this is not adways possible, due to heavy demands on the aircraft.) Because total suppression time on fires was reduced, deployment crews did not have to be resupplied after the initial flight, which further reduced helicopter flight time.

And finally, the loss of manpower which would have resulted from using logging crews or other specialized personnel on these fires was avoided. Rappel crews can be utilized in helispot construction during heavy fire activity, thereby increasing the efficiency of conventional crews.

Men Better Served

Men were always placed within 40 yards of the fire using the rappel deployment technique, closer placement being limited by the effect of the rotor wash on the flames. They were also placed within a foot of their desgnated deployment spots, so that they were able to select firm footholds even in rough terrain. Equipment was sent down to the same location. Thus rappel deployment crews did not have to spend time locating the fire or their equipment or both, but were fresh, fully equipped, and ready for immediate control action as soon as they were set down at the fire.

The project which has developed this technique is part of a comprehensive initial attack research program currently in progress at the University of British Columbia. However, the deployment of personnel from hovering helicopters promises to be useful in the construction of helispots for conventional crews and equipment, in other aspects of fire control and forest management, and in safety and rescue work as well. But like any specialized technique, the capabilities of the rappel deployment technique must be fully understood if it is to be used to capacity.

[1] Henderson, Robert C. Progress Report: Operational Evaluation of Helicopter Deployment Technique (206 U.B.C.) Nov. 1972 Univ. B. C.

Rappelling, An Alternative

Ian D. McAndie

Forest fires must be attacked quickly. In remote areas of the Western United States, smokejumping is a fast means of getting men on the fireline, yet there are limitations to smokejumping. It is hazardous to drop jumpers into snag patches where parachutes will hang up in the top of a dead, dry, brittle snag (fig. 2). When they do, snag tops very likely break off, causing serious injury to the jumpers as they freefall to the ground. Steep, rocky areas strewn with large boulders are also hazardous to smokejumpers. Wind in excess of 15 miles per hour reduces jumpers' pin-point accuracy and increases chance of injury by causing them to hit the ground harder.

However, an alternative to smokejumping is to rappel from the helicopter directly to the fire.

Rappelling Investigated

The Forest Service's Redmond Air Center is investigating rappelling from a large turbine-powered helicopter and rappelling's application to the tall timber areas of the Western United States. Rappelling is as old as the art of mountain climbing. Webster's defines it as, "descent of a precipitous cliff by means of a double rope passed under one thigh, diagonally across the body and over the opposite shoulder."

Rappelling from helicopters however, is a modern technique using more sophisticated equipment than the double rope mentioned by Web-

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Figure 1.—Rappelling into an opening in 200-foot timber.

Figure 2.—Typical dangerous snag area.

ster's. The military have used the rappel to place troops on the ground where it was not possible or too dangerous to land a helicopter. The Bureau of Land Management in Alaska has developed a technique to deliver firefighters onto tundra areas and into areas of short scrub spruce timber.

But until then, no one had attempted to rappel into the 200 to 250 foot tall timber found in Oregon and Washington.

When we at Redmond began our investigation of the rappel idea, we acquired available literature, information, equipment, specifications, and training material on helicopter rappelling. The BLM office in Fairbanks, Alaska, sent us a set of the equipment they had used, along with a slide program and training outline. After review of all this material, we developed a prototype equipment and training package. Descent Control Company's "Sky Genie" was adopted as the descent control device. It is a lightweight, device (fig. 3) on the cord; starts, stops, and decelerates with fingertip pressure to control rate of descent.

Equipment Modified

Harnesses, similar to those used by smokejumpers, were made, incorporating quick release hardware in case the rappeller should be unable to unhook his Sky Genie. There might be the possibility of turbulance causing the helicopter to move, dragging the rappeller before he could free himself. The quick release will allow him to drop free from the line. A knife, sheathed on the harness, can be used to cut the line.

A standard Toptex smokejumper helmet and facemask were provided for head and face protection. Heavy leather gloves were a must, and sturdy jumper boots were also required.

"Hard point" connectors on which the letdown ropes fastened were adapted to fit the "iron cross" on the overhead of the Bell 205A-1 helicopter (fig. 4). Safety harnesses for the

spotter and rappellers were designed to prevent them from accidentally falling out.

Smokejumpers Trained

Training of a rappel crew began with selecting 13 smokejumper volunteers to participate in the test program. Leo Edmo, helicopter foreman, was trained along with the smokejumpers. Pat McCauley, jumper squadleader, headed the field project. On August 21, 1972, the first actual helicopter rappel at Redmont Air Center became history. Dan Dunnigan made the first rappel that afternoon followed by Rich Neher, Roger Mull, and Bruce Wright. The first rappels were made from an altitude of 50 feet, then up to 100 feet.

A tall timber (250 foot) rappel and an actual fire rappel with a six-man crew were the ultimate goals of the training program. Employment ran out for all the trained rappellers, except Leo Edmo, so five Air Center permanent personnel were trained to complete the project. Bruce Cheney, Walt Baas, Byron Bonney, Wayne Linville, and Ian McAndie were given classroom and tower training. The six men made the required training rappels and were ready for the tall timber "moment of truth."

Tall Timber Use Successful

On September 20th, the tall timber rappel was made near Glaze Meadow, northwest of Sisters, Oreg. The helicopter and crew arrived over the rappel spot at 1330 hours above 200-foot tall timber. The six men successfully rappelled from the helicopter to the ground in less than 2 minutes. We proved that rappelling from helicopters (medium, turbine-powered helicopters) into the tall western timber is not only possible, but practical as well, for delivering firefighters to remote, inaccessible areas. Unfortunately, rapplers were never used on an actual fire.

Use Defined

Some conclusions drawn from the summer's experience are:

1. The helicopter is *another* means of delivering firefighters to a fire, either by rappelling or landing close by.

2. Rappelling will likely not replace smokejumping because (a) the 205A-1 can only carry a six-man crew compared to 16 in a DC-3, (b) the 205A-1 costs $850.00 per hour as opposed to $167.00 per hour for a DC-3, and (c) the helicopter is limited to 78 miles one way due to fuel weight restrictions; jumpers have a much larger range. Larger helicopters may balance the manpower advantage in the future, but cost will probably remain much higher.

3. Rappelling should not be done if the helicopter can land within 8 to 10 minutes walking time of the fire. The time that the ship is "on station" completing rappels and cargo delivery is hazardous to the men on the ground and to the aircraft because it is operating below safe autorotational elevation. Eight minutes is the maximum time to spend at hover elevation due to turbine heat being forced down onto the tail boom.

4. Rappellers are not restricted to airfield facilities as are jumpers.

5. Rappelling from helicopters is a practical means of delivering firefighters when other means are not possible.

Figure 3.—Sky Genies in place on letdown line.

Figure 4.—"Iron Cross" in position on overhead of Bell 205A-1. One letdown rope leads out each door.

Rural Fire Defense unit personnel saved more than $10.6 million in property during the 1971-72 fiscal year ending June 30th. They worked 1,451 calls, of which 60 percent involved structures and equipment, and 35 percent consisted of forest and grass fires.

Rural Fire Defense Program Initiated in Georgia

Thomas R. Fontaine, Jr.

The Georgia Forestry Commission, in cooperation with county and local governments, has initiated a Rural Fire Defense Program in many areas unprotected by organized fire departments.

The program assists county areas that need fire equipment for suppression of structural fires adjacent to suburban areas and for grass or debris fires.

Volunteer rural fire departments support fire suppression efforts of the Commission, which used to be called to many of these fires. When forest fires occur in their local area and equipment is available, the volunteer fire unts also support the Commission.

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Surplus Equipment Provided

The Commission provides suppression equipment, which is maintained and housed by the local rural fire department. This equipment is surplus from the Federal Government and the Forestry Commission.

Pulaski Starts With Two Tankers

An example of local and State cooperation is the Pulaski County Rural Fire Department.

Organized in April 1971, in cooperation with the Georgia Forestry Commission, the Pulaski department leased two tankers from the Commission. County residents helped finanee the operation by approving a 1-mill tax assessment. County Commissioner W. A. Sapp said collections were $7,000 for the first year, and are paying for equipment.

Equipment expenses include the purchase of a pumper and the equipping of the two tankers with 375 feet of one inch hose, 150 feet of one-half inch hose, hose reel, pump, tank, tool rack, radio, hand tools, warning lights, siren, and electric starter.

The Department Grows

Besides the two tankers, 1,000- and 1,200-gallon capacities, the department's equipment now includes a 6,000-gallon tractor trailer that was

converted to a fire truck, a 750-gallon pumper, and a 300-gallon tank on a jeep.

The structural facilities of the department include an administrative office, a training room, a four-stall fire house, a locker-shower room, and a kitchen. The county constructed the firehouse and also furnishes equipment maintenance, gas, and oil.

The department has 21 volunteers with one full-time employee, Sam Clark, who is also the county Civil Defense Director.

Three Things Insure Success

The Pulaski department's efficient suppression action is based on three things: the cooperation of county citizens; the use of county map with numbered fire roads, and a modern communications system.

At the program's start, Clark visited every home in the county. He told residents how to contact the department in case of fire.

He gave each resident a packet that contained contact procedure instructions, the county map showing the fire roads, and a telephone sticker with the home owner's fire road number on it. Clark devised the system for numbering each road, and numbered signs identify every road, from outside the city limits to the county line.

The communications center is located at central headquarters. It includes a citizens band, county, and Forestry Commission networks. The citizens band is also in all trucks and volunteer private vehicles; the county system is in all department trucks; and the Forestry Commission network is in the Chief's truck.

On night calls, the fire phone rings at a local funeral home. The operator there pushes a buzzer which activates one siren near the fire department and another at the court house. The first man on the scene of the fire operates the radio. He advises the dispatcher when firemen arrive. Approximately 15 men answer every fire call.

During the first year of operation, the department answered 29 calls: 14 grass, six mechanical, and nine structural.

Training Is Important

The volunteers have recently completed a 120-hour course at the Georgia Tech. Fire Institute, in all phases of firefighting. As a result, the department was approved by the Southeastern Underwriters' Association. This reduced homeowner fire insurance costs from 10-30 percent.

In addition, the volunteers have completed the Forestry Commission's field and brush fire course. The course included field burning, house fires, and prescribed burning and was conducted by Tommy Hogg, ranger, Pulaski County Forestry Unit.

Hogg points out that the volunteer fire control group makes more effective fire suppression efforts by the Pulaski County Forestry Unit. The RFD Department advises on burning or threatened burning of forests. In addition, it supports the local State forestry unit when a wildfire occurs and equipment is available.

Georgia's Program Successful

Fred H. Baker, Forestry Commission RFD coordinator, reports that, Statewide, equipment issued through June 1972 totals 329 pieces of equipment in 127 counties and involves 269 departments. There are 38 requests for equipment pending.

In Georgia, the Rural Fire Defense Program enables the Forestry Commission to better serve the State.

Tommy Hogg, ranger, places the Commission sticker on a tanker while Sam Clark, fire chief of the Pulaski Fire Department, watches. The Rural Fire Defense Program, developed by the Georgia Forestry Commission in cooperation with county and local governments, involves 269 communities in 127 counties. Shown here and featured in the article is the Pulaski RFD.

Infrared Imagery Aids Mop-Up

Howard V. Hawkins

Infrared imagery (IR) helped fire bosses determine mop-up needs for the Carman and Lily Fires on the Tahoe National Forest, California. Even though visibility of the fire areas was never a problem, and, even though fire lines were completed around the entire perimeter, IR surveillance paid off in determining critical hot spots and amount of mop-up necessary.

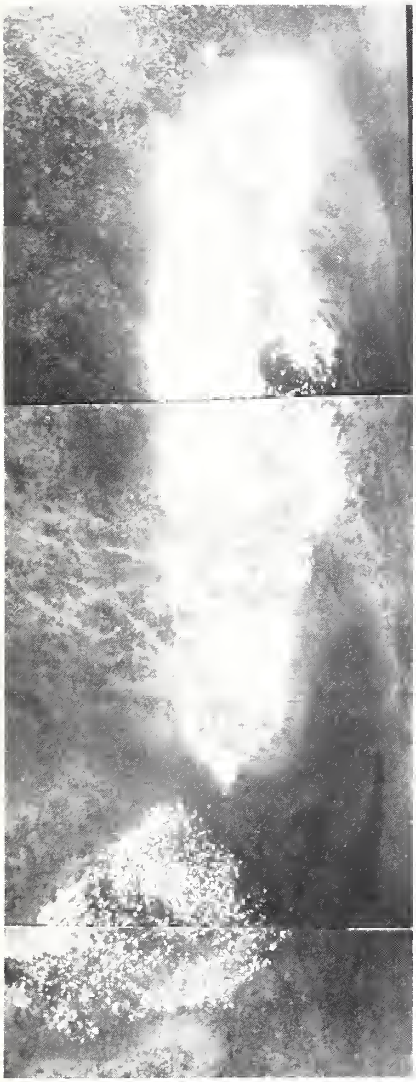

Figure 1.—The Carman Fire had heavy fuels and burned hot. Spots were easily detected thanks to IR imagry.

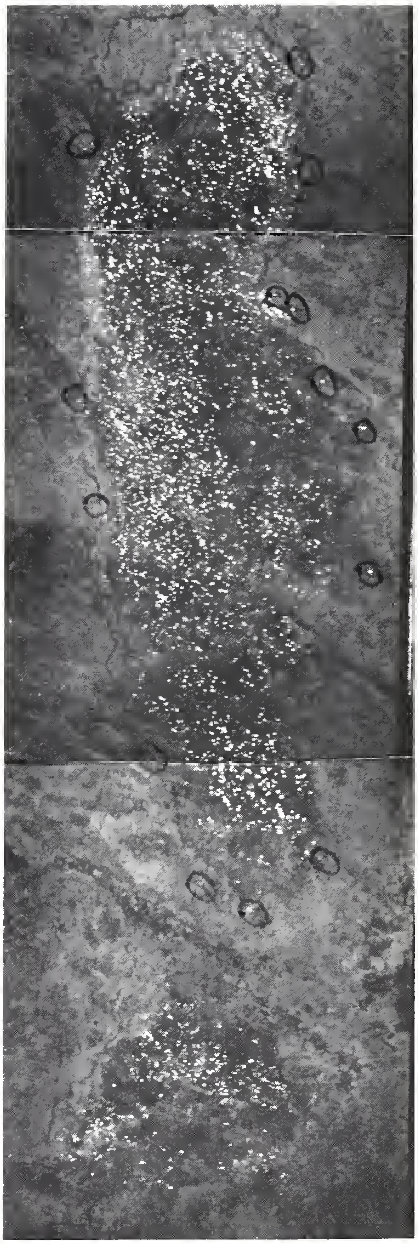

Figure 2.—Spots inside and outside the Carman Fire were easily detected, and mopup was therefore thorough.

Carman Fire Could Have Been Bad

The Carman fire (fig. 1) occurred August 8-14, 1972, and burned 2,000 acres. Fuel type consisted of heavy reproduction, medium mixed brush, and heavy concentrations of old logging slash. The fire had burned hot, spotting well ahead of the main front and along both flanks. These spots were mostly in old punky logs, stumps, and decayed material.

Without IR imagery, some spots would probably have escaped detection. Weather conditions were unfavorable throughout the campaign; the forecast called for continued strong winds, high temperatures, and low humidity and fuel moisture.

The fire boss requested IR imagery of the fire to plan for the first shift of mop-up. The imagery (fig. 2) helped fire fighters plan an efficient mop-up. Fire spots both in and outside the line were located along with areas of concentrated heat close to the line. Problem areas were easily identified and priorities for mop-up crews were quickly established.

Lily Fire Could Have Been Worse

The Lily fire (fig. 3) burned 250 acres the first afternoon. Fuel loading was heavier, with more old logging slash on the ground than the Carman

Fire had had. The fire burned hot and spotted badly. And again, the fire boss requested IR imagery of the fire area to help mop-up operations.

A weak warm front passed through the area, causing light rain during the early morning hours of the second day and intermittently for the next 2 days. A total of 0.75 inches of precipitation fell on the fire area during the 2-day period largely extinguishing the fire. Soon the fire camp was dismantled, and all off-Forest fire personnel were released.

Prior to the storm six 25-man crews plus water equipment would have been required for three shifts to complete the mop-up job. However, after the storm no one knew how much fire remained; therefore estimation of mop-up manpower needed was difficult. Because of the volume of fuel, considerable fire might have survived the rain. Therefore, the fire boss decided that a small fire camp and four 25-man crews, plus pumping equipment, could complete the mop-up job. But then the fire boss asked for an IR run.

The imagery (fig. 4) showed less heat than had been anticipated; only a few hot spots remained, with nothing outside the line. One 25-man crew completed the mop-up in 2 days, working out of the local Ranger Station. Three 25-man crews and one fire camp were eliminated — for a significant saving.

IR imagery played a vital role in helping plan an efficient mop-up effort in both fires by pinpointing locations of trouble spots immediately after the control lines were completed. The imagery can also be credited with a large contribution to the success of holding some very difficult lines during extreme burning conditions.

Figure 3.—Fuels in the Lily Fire were heavier than in the Carman Fire (see figs. 1 & 2). The fire burned hot and spotted badly.

Figure 4.—Weather cooperated and dumped rain on the fire. Because some fire may have survived the rain, an IR detection flight was made. Only a few hot spots remained, none outside the line.

Lightning Sensors Tested

Peter Kourtz

Because lightning causes so many fires, scientists in Canada are testing the effectiveness of five designs of lightning sensors. One of the sensors will be tested, based on a computer model, in 1973.

Lightning is responsible for the ignition of approximately 20 percent of Canada's forest fires. In regions such as the interior of British Columbia, northwestern Ontario, and western Quebec, more than 50 percent of the forest fires are started by lightning. A significant proportion of the lightning-caused fires remain dormant and difficult to detect for a considerable time after their ignition. These fires become easily detectable at the same time that they enter a rapid-spread phase. A special effort is required to find these fires before they enter this phase, otherwise, the near simultaneous appearance of a group of these fast spreading fires may overtax fire fighters.

It is standard practice for most forest protection agencies to supplement their existing detection system with additional visual air patrols in the areas thought to be hit by thunderstorms. However, detection dispatchers rarely know the actual area over which each storm passes. The resulting detection patrol routes are usually based on incomplete storm reports from forestry field stations and on general lightning-caused fire occurrence maps. A much larger area than necessary may be patrolled or an area with lightning-caused fires may be missed completely.

Sensor Network Needs Improvement

The existing storm tracking procedure that consists of field personnel reporting the occurrence of thunderstorms in their locale frequently fails mainly because humans are poorly equipped to detect distant lightning. Storms that occur during the night or in remote areas can go completely undetected. Sophisticated combinations of weather, radar, and spherics equipment, capable of accurately tracking storms over large areas are available, but their costs are too high.

Lightning Sensors Tried

Another approach now seems feasible. The concept involves a dense network of inexpensive, limited range, electronic lightning sensors. These sensors would be located at existing forestry weather stations and field offices and would provide a count of the number of lightning flashes that occurred within their range. Such counts would be relayed, possibly along with weather data, to central collecting points where storm tracks could be plotted and detection patrol routes determined.

In 1971 the Forest Fire Research Institute began a program to develop a storm tracking network based on this concept. The initial phase of this work involved the testing of a research instrument on loan from and designed by Project Skyfire of the USDA Forest Service. This instrument detected thermal infrared radiation that is emitted by a lightning strike and it appeared to have a maximum range of 10 to 25 miles. Its major problems were its short battery life (2 to 3 weeks) and its fluctuation in range from night to day caused by its sensitivity to solar radiation.

Four Sensors Selected

Early in 1972 the Institute contracted the construction of four designs of lightning sensors. These were placed at a site located on the Central Research Forest of the Canadian Forestry Service near Ottawa. A brief description of these four instruments follows:

1. Sensor 1 was a modified version of the Skyfire sensor that was tested the previous year. It was designed to operate on a 110-volt power supply in an attempt to overcome the short battery-life problem. So that the radiation-collecting apparatus could be mounted on a tower, it and electronics were separated from the digital counter and power supply.
2. Sensor 2 was a more sophisticated infrared radiation detector. It was an entirely new design that used batteries and had low power drain. In theory, it was capable of detecting lightning equally well in the daytime and

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at night. Also, the sensor had a dial on its front panel that was calibrated in terms of the minimum flash duration required to trigger a count. This discrimination between long and short duration flashes was done by a time mechanism built into the electronics of the sensor.[1]

3. Sensor 3 was an electromagnetic receiver specifically designed for the project and was sensitive to a wide range of frequencies centered at about 100 kilocycles per second. It had an antenna about the size of a tennis ball and was battery operated.
4. Sensor 4 was an electromagnetic receiver sensitive to signals between 100 cycles and 2 kilocycles per second. It had a very large antenna resembling a multi-strand clothes line about 45 feet in length. It was battery-operated and battery life was very long.

Each of the four sensors had a small set of electronic components and a digital counter. Sensors 2, 3, and 4 had built-in circuitry for performance testing and sensor 4 had a built-in battery tester.

Each of these test sensors was connected to a common four-channel event recorder that noted the exact time when each instrument counted. Such a recorder would not be necessary on the operational sensors since the goal of a sensor network would be to indicate where thunderstorms had occurred since the last time that the sensor counts had been read.

None of the four sensors was capable of distinguishing between cloud-to-cloud and cloud-to-ground flashes. The initial goal a network of these sensors would be to track thunderstorms, and with this type of equipment the underlying assumption would be that cloud-to-ground lightning likely has occurred if the sensors register counts.

[1] Fuquay and Taylor (1972) have shown that long duration flashes are most likely the cause of forest fires. Future research with this instrument will attempt to correlate counts of long duration flashes with the occurrence of forest fires.

Sensor Sensitivity Varies

The sensors were installed at the test site in mid-May 1972. Between this time and the end of the first week of August there were 28 separate thunderstorms within a 20 mile radius of the site. The site and surrounding region were covered by two weather radars located in Ottawa and Montreal. The Ottawa radar provided permanent hourly records of cloud activity and 5-minute interval records were available from Montreal. In addition, current storm location information could be obtained on request from both radars.

Sensor 1's power problem of the short battery life was overcome by converting to a 110-volt power supply. However, this conversion introduced troublesome electrical noise that caused the counter to average about 20 counts a day, with or without storms. For this reason further tests with the instrument were abandoned by mid-July.

Sensor 2 regularly exhibited brief, but deceptive, periods of electronic instability. This, plus the instrument's limited range clearly indicated that more testing and adjustments must be made.

Sensor 3 proved to be a very dependable instrument with an adequate range. Its small, easy-to-mount antenna made it a definite candidate for a large thunderstorm tracking system.

Sensor 4's performance was near perfect during the entire 3-month trial. It had an estimated range of 20 miles and did not require a battery change even though it was run continuously for close to 100 days. Only lightning produced enough energy to make it count. The one drawback to this sensor was its large antenna which had a material cost of less than $30 but required about 2 man-days to construct.

Fifth Sensor Tried

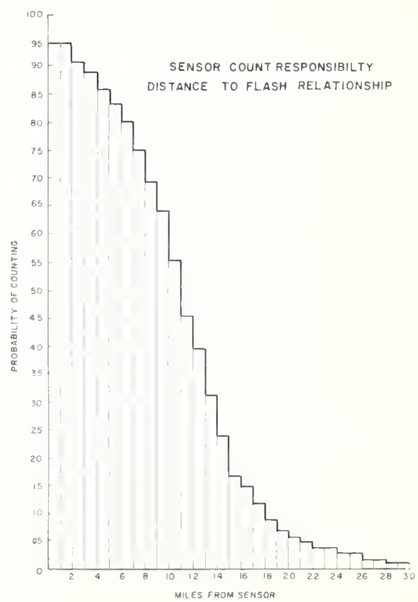
Near the end of the trial period a fifth sensor made by the Honeywell Corporation, Minnesota, was installed at the test site. This sensor detected magnetic radiation produced by lightning strikes and did not require an external antenna. Its range was adjustable and it could be operated from batteries or a 110-volt power supply. Exposure to a limited number of storms indicated that, at an intermediate range setting, its performance in range and frequency of counts almost paralleled that of sensor 4.

In sensor 5, unfortunately, a minor electronic problem introduced an annoying instability, and the instrument was returned for repair. However, sensor 5 seems to have a sound basic design and the potential of being an excellent lightning sensor.

Sensor 4 To Be Used in '73

During the thunderstorm season of 1973 it is planned to test the storm tracking concept in a large area of Ontario. Sensor 4 has been chosen for this test in favor of sensor 3 chiefly because of its "clean" circuit design, its low production cost (less than $300), its problem-free long-duration power supply, and its lack of electrical noise interference.

The plan is to place 20 to 25 sensors at existing forestry field stations



that have radio contact with the region's central fire control command center. Each morning the sensor counts will be radioed into the center where a plot could be made of the thunderstorm paths and special lightning patrol routes planned.

A computer simulation model of the proposed network was developed in an attempt to identify future problems. Each simulated thunderstorm took the shape of an ellipse, and for each storm, the locations of a specific number of lightning strikes were randomly generated within the ellipse. The ellipse's length, width, center location, and orientation angle and the number of lightning strikes per storm were defined at the beginning of each simulation run. The graph presents the assumed distance-to-flash count probability relationship used by the Monte Carlo procedure to determine the number of counts on each of the network's instruments.

The results of use of the model indicated that the scheme should work well provided that a dense network of sensors can be established. Overlap of sensors provides useful information; however, this overlap should not be achieved at the expense of leaving large areas without coverage. Also, low sensor counts probably should be attributed to storms further away than 20 miles. Future work with this model will examine the importance of a longer range, directional sensor including directional resolution and sensor spacing.

Our research during the next year will be concerned with the development of a smaller antenna for sensor 1, the continued testing and refinement of sensor 2, and the attempted development of an inexpensive directional sensor with an extended range.

Reference

Fuquay, D. M. et al., 1972. Lightning Discharges that Cause Forest Fires. J. Phys. Res., Oceans & Atmos. Vol. 77, No. 12.

Did You See These Equip Tips?

The following publications, Equip Tips, are available free on request from the Chief, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Equip Tips are short accounts of developments or tests.

The author for each is shown as MEDC for Missoula Equipment Development Center, SDEDC for San Dimas Equipment Development Center, and BEC for Beltsville Electronic Center.

Compoct forest fire simulotar	5100	Octaber 1972	MEDC
Improved dispasable sleeping bag	5100	May 1972	MEDC
Reflective materials for night firefighters	5100	March 1972	MEDC
Protective chaps far chain saw aperotors	6170	February 1972	MEDC
Field first-oid statian	6170	Februory 1971	MEDC
Axes and pulaskis improved	5100	July 1971	MEDC
A mobile mixing bose far Phos-Chek fire retardants	5100	May 1971	MEDC
Flame resistant cotton shirt and plastic tent fly	5100	March 1971	MEDC
Fire plows adaptable ta the vertical lift hitch	5160	October 1970	SDEDC
Plastic fire nozzle evaluation	5160	October 1970	SDEDC
Warning system far chain sow aperotars	6170	October 1970	MEDC
Multi-hitch trailer caupling	7100	September 1970	MEDC
Collapsible fabric tanks	5100	Rev. May 1970	MEDC
Direct reading humidity-temperoture indicotar	5100	March 1970	BEC
The SPAR aerospace hatspotter	5100	March 1970	BEC
Portable lighting unit far firefighting	5100	January 1970	MEDC
Safety guard far bow saws and bar saws	6100	September 1969	MEDC
Air-to-ground warning device	5170	July 1969	SDEDC
Bracket far light helicapter cargo haaks	5170	July 1969	SDEDC
Crawler-tractar lubricating kit	5100	May 1969	MEDC
Law cost bow-saw guard	6100	May 1969	MEDC
75-, 125-, ar 200-gallan tap-maunted, plastic (madel 30) slip-an tanker	5160	October 1968	SDEDC
Quick release packboard straps	6170	August 1968	MEDC
Improved farest fire shelter	5160	June 1968	MEDC
Callapsible fabric tanks	5100	March 1968	MEDC
Safety footwear	6170	February 1968	MEDC
75-, 125-, ar 200-gollan end-mounted, metal slip-an tanker	5160	Jonuary 1968	SDEDC
How to prevent chain saw kickback	6170	October 1967	MEDC
Free falling cargo from helicopters	5730	July 1967	MEDC
A new 50-gallan slip-an tanker	5160	February 1967	SDEDC
Helicopter ratar dawnwash effects	5700-9	June 1969	SDEDC
Bell 204B external helitank evaluatian	5700-8	June 1969	SDEDC
Campoct simulatar campanent list	5100	August 1970	BEC
Measuring physical fitness af forest service personnel	6170	August 1970	MEDC
Emergency lacatar transmitters	5100	July 1970	BEC
Maintenance instructions for gouge isalotar system	5100	Jonuory 1970	SDEDC
Woter hondling equipment guide	5100	November 1969	SDEDC
Troctor mounted implement hitch evaluatian	7120	January 1968	SDEDC

The Helicopter Bucket . . . A Versatile Tool

Excerpted from a letter by K. O. Wilson, Assistant regional forester, Region 6

The helicopter bucket is a close-range weapon which can take advantage of man-made or natural water sources in the proximity of the fire.

The helicopter bucket firefighting program, since its beginning, has grown rapidly. In fact, Forest Service helicopter pilot Lawrence H. Johnson has already visited Viet Nam to help establish a helicopter bucket fire suppression program for military and civilian fire brigades there.

Use Varies

Helicopter buckets are deployed in a number of ways depending upon the behavior of the fire and the tactical objective. For initial attack, some National Forests dispatch buckets loaded with retardant to the fire, drop the retardant on the fire, and then use the nearest hoverfill water source to continue attack with plain water until ground forces arrive.

Other Forests transport the fire crew and bucket together in the helicopter to the fire. The helicopter lands the crew near the fire; the bucket is attached; and the helicopter is sent to the nearest water source to provide supporting water drops for the men on the ground. If the fire escapes and grows to major proportions, chemical retardant hoverfill plants are established close to the fire, and helicopter buckets are used to support line construction efforts of ground crews.

Dumping Is an Art

Accurate placement of water loads is a matter of the pilot's proficiency. He can vary airspeed and rate of discharge and get an infinite array of patterns on the ground. The pilot must also practice placing his load under a variety of conditions and rates of applications. The accurate placement of helicopter bucket drops is an art more than a science, and there is no substitute for experience.

The downwash from a hovering helicopter can fan a fire and increase its intensity and rate of spread. With small helicopters carrying 50 to 150 gallon buckets this is not a serious problem when the hover is for a few seconds and at least 75 feet above the fire. Larger helicopters with 300 to 1,000 gallon buckets can seriously disrupt a fire unless the hovering elevation is above 300 feet. Drops with larger helicopters at elevations below 300 feet should be made with at least 15 mi/h forward speed.

Wetting agents are used only with the Sims fiberglass helicopter bucket because it includes an automatic pump and reservoir system to inject the wetting agent automatically as the bucket is filled. Wetting agents greatly increase the effectiveness of helicopter water drops.

The Sims Fiberglass Company, the original fabricators of fiberglass buckets, and other bucket manufacturers have sold many units here and aboard. Fire equipment warehouses keep buckets on hand for issue to major fires.

Where helicopters are available, the bucket has earned the right to be regular Forest Service firefighting equipment.

Forest Fire Management - For Ecology and People

Jack S. Barrows

Let the forests burn? The provocative theme of this 1973 technical session is punctuated with a question mark.

Specific questions about letting forests burn involve considerations of ecology, outdoor recreation, timber supply, watershed protection, air and water pollution, and public safety. They are questions of why, when, and where.

Of special interest to foresters are the questions of how forests can be burned safely and efficiently to satisfy the needs of ecology *and* people. Also there are the critical questions of who develops the policies, makes the decisions, and assumes the responsibility for the effects of forest fires.

I regard the present interest in reexamining forest fire policies as a healthy and timely development. Many forest fire control agencies have been doing this for some time. Professional fire personnel have long recognized the natural role of fire in some forest ecosystems. They have developed advanced technology for use of fire.

Our knowledge of forestry and natural resources is now at a stage where a higher degree of sophistication in dealing with the many questions about forest fires is permitted. In particular, the advances in forest fire science and technology permit the development of significant new approaches to fire use and control.

If we are to achieve the potential benefits from an expanded role of use of fire, while at the same time minimizing the hazards, it is critically important to develop appropriate concepts for the job at hand. We must gain a keen understanding of the whole galaxy of problems associated with both wanted and unwanted fires.

The phrase—*Let the forests burn*—whether used as a question or a slogan, is a gross over-simplification of the problem. Putting fire to beneficial use is a complex matter that cannot be answered by the simple expedient of letting the forests burn.

Management Makes the Scene

However, there is an approach that will provide a coordinated program responsive to the complexities of forest fires. That program is appropriately termed Forest Fire Management.

First of all, forest fire management is based upon the concept that *fires in the forest may be either good or bad*. It also recognizes that the same fire may be good for some aspects of a forest ecosystem and at the same time be bad for the needs of forest industry or of public safety.

Forest fire management is designed to resolve these conflicts. It applies management policies and technology for both wildfires and prescribed fires. It recognizes that factors of time, location, fuel flammability, ecology, and economics may make forest fires either wanted or unwanted.

Forest fire management provides systematic application of the alternatives for fire use, fire prevention, and fire suppression.

Adapted from paper presented at Society of American Foresters, student chapter technical session, Colorado State University, by Jack S. Barrows, Dept. of Forest and Wood Sciences, College of Forestry and Natural Resources, Colorado State University.

Training Aid Guide Available

Training Aids for Forest Fire Control Instructors, containing a wealth of specific information for wardens, rangers, fire chiefs and others working in rural areas, has just been published by the National Fire Protection Association (NFPA).

This new 32-page booklet (8½ by 11 with pages punched for notebook use) describes aids available; suggests how, where, and when to use them most effectively; and includes a detailed index of where to order the various materials.

Reference texts, information and technical bulletins, motion picture films, slide-tape programs, and filmstrips are some of the items covered. There is information on training devices such as the fire triangle, teaching machines, lesson plans, fire simulators, string fires, sand boxes, and fire tables, as well as information on standard teaching equipment.

Prepared by the NFPA Forest Committee, *this booklet is intended as a guide to the variety of training aids available and as a help to the trainer in selecting the aids of most value in his particular situation.*

Copies of "Training Aids for Forest Fire Control Instructors" (NFPA No. FSP-32) are available at $2 each from the NFPA Publications Service Department, 60 Batterymarch St., Boston, MA 02110.

VFW Applauds Prescott NF

The Prescott National Forest in Arizona is recipient of a certificate of appreciation from the Veterans of Foreign Wars, Post No. 10233, in "special recognition and highest praise for alertness, personal courage, and efficient guardianship of life and property" in connection with suppression of the 28,389 acre Battle Fire spring 1972 in the Prescott NF.

A Different RH Factor

Relative Humidity Relationships Vital To Woods Operations

Robert P. Matthews

The importance of relative humidity as a hazard indicator ought to be judged by your local conditions. For this reason standard curtailments, such as 30-percent-level laws, become less important.

Knowledgeable forest managers and forest fire specialists recognize that fine fuel moisture is greatly influenced by relative humidity (RH). Wind and fine fuel moisture are the most significant factors affecting fire behavior and, therefore, logging operations. Wind speed can be perceived by an observant logging operator; however, fine fuel moisture must be measured.

Although fine fuel moisture might be a more appropriate component to measure, there are no such instruments currently available to do the job. Therefore, RH has traditionally been used because it fluctuates in a manner similar to fine fuel moisture.

Importance Varies

Relative humidity is not nearly as significant a factor in some operating conditions as it is in others. The decision to curtail woods operations should be based on considering the combination of RH, fine fuel moisture, and the availability of punky wood or heavy duff. Punky wood or duff catches and holds live sparks coming from logging equipment exhausts or from friction of cables or logs.

RH is not as significant a factor in areas of low fire hazard where fuel moistures remain relatively high. However, in operations in higher mountain areas, particularly where experience indicates that relative humidity may change rapidly, RH is cause for much concern.

Robert P. Matthews is director, Forest Protection, Washington Forest Protection Association, Seattle.

Punky Wood Ignites

The availability of punky wood significantly differentiates the degree of hazard between the typical Northwest inland pine forest types, which have relatively light fuel and little punky wood, and Pacific Slope conditions, which are characterized by heavy fuels and an abundance of punky wood. Logging operations can continue at lower humidities in the pine types where fuel conditions are much less severe and fires more easily controlled. In the heavy fuel types created by harvest of Douglas-fir and hemlock forests, however, a fire igniting on a day of low RH in heavy fuels is extremely difficult to control even when prompt initial action is taken.

Research has shown that sparks can be introduced into a dry pine needle bed at a given level of RH without igniting the fuel. However, under identical environmental conditions, sparks introduced into dry punky wood or crushed pine needles will catch and hold a spark which can be readily fanned to flame by a light breeze. The importance of RH to logging operations, therefore, is based on the probability of sparks contacting dry punky wood.

Tailor Your Tasks To Local Conditions

As the fire season progresses and total dryness of the entire forest complex increases, you ought to curtail operations at higher levels of RH than you did during the earlier periods of the season. Also, you must learn to interpret the effect that wind speed and slope will have upon a fire should it start in your operation.

Sometimes operations are modified during periods of critical fire danger. For example, since sparks from chain saws are one of the most significant contributors to logging operation

caused fires, felling operations are stopped before high lead yarding operations.

Or both felling and yarding operations are stopped and only loading and hauling operations continued, provided sufficient fire suppression capabilities exist at the landing and provided haul roads do not traverse large areas of high hazard. As conditions become more critical, operations may stop altogether.

Specifications Can Guide

The above decisions cannot arbitrarily be regulated by laws. They must be individually established for each given set of circumstances. Such decisions can best be accomplished by contract specifications geared to the fire season and hazard in the area in which operation is being conducted, coupled with knowledgeable interpretation and action by prudent operators.

Laws Are Rigid

Because of the wide disparity of effects RH has on individual operations, it is unrealistic to enforce mandatory curtailments when RH reaches a specified level. Some States have had a RH law which called for curtailment of operations at the 30 percent level. This was abandoned in favor of the more sophisticated measurements of fire danger.

It is not good judgment to rely upon statutory curtailment because periods of low RH can occur when the ground is covered with snow or fuel moisture can be such that overall fire danger is not critical. However, it is also poor judgment to rely upon region or district fire danger ratings for curtailment of operations that are located in extremely hazardous fuel types where a fire could be disastrous. For these reasons, *it is essential that logging operators understand and interpret the significance of RH upon their individual situations.*

Modifications Mean Smooth Operation Of Compact Simulator

John D. Steffens

Learning from experience, personnel in Region 4 improved the storage, setting up, and operation of the Compact Simulator.

When the crew received the Compact Fire Simulator there were, in addition to the simulator, two trunks and a large "suitcase" full of equipment, as well as four photoflood stands. The photoflood stands were to support the blackout curtains on either side of the screen. The trunks contained electronic gear and wire. The large "suitcase" contained the portable rear projection screen and blackout curtains. We opened the trunks of electronic gear and with the instruction book in hand, we connected up the different types of audio systems.

Audio Problems Solved

Because our audio components seemed mismatched, we use the wired open communication channel with the stereo amplifiers without a preamplifier.

The wireless open communication channel is ineffective inside of the building. Besides, a lot of people use CB channels, causing interference with our training exercise. So we no longer use the wireless open channel.

Although the telephone communication channel works well, it was unrealistic. It will be used in the future on zone type exercises. We use the wired open communications channel and the director intercom network for all of our radio simulation.

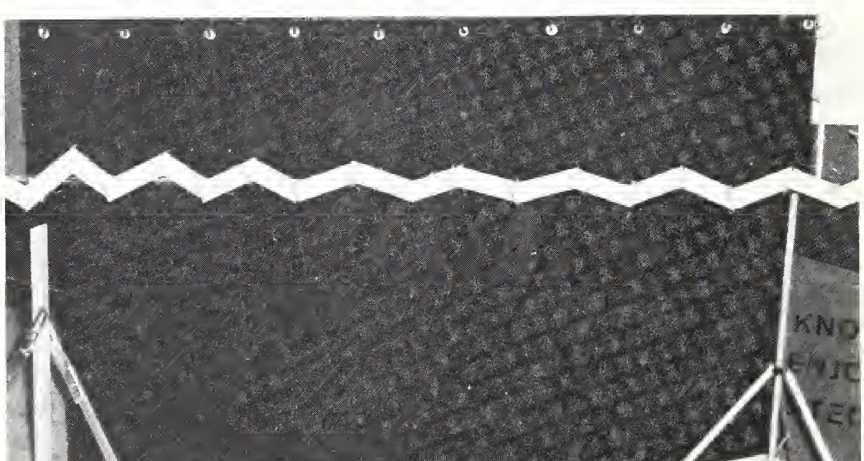
The original wiring diagram provided realistic background sound only for the trainees. We discovered that the role player speaker could not be heard by all observers. To correct this, we placed another speaker in the rear of the training area. It gave observers an opportunity to follow the exercise and make their own decisions and criticisms. We used two speakers for the trainee too.

Blackout Curtains Secured

The photoflood stands presented a safety hazard. To hang the blackout curtains, we strung shroud line between the stands and draped the curtains on the shroud line. At best, this was a precarious arrangement, subject to instantaneous toppling. So for each support, we welded a series of

John D. Steffens is forester, Spanish Fork Ranger District, Unita NF, Utah

Figure 1. Rigid stand and modified electrical conduit crossbar makes use of blackout curtains safer.



hooks to thin wall electrical conduit cut as long as the blackout curtains were wide. The grommets of the curtains were spaced to fit over the hooks. The conduit was also fitted with a device that slipped into the tube on the photoflood stand. To connect the conduit to the screen frame, we designed an adaptor. When the whole system was set up, we had a rigid stand and crossbar that could withstand considerable knocking about without toppling.

During early exercises, role players looked at the scene from the rear and had trouble with direction orientation. We solved this by taping orientation signs on the borders and opposite side of the screen.

Another problem was loosening of screws on the motion-creating grids by the smoke and fire motors resulting in loss of motion to the smoke and fire simulations. We now check and tighten the screws before every simulator exercise.

Timing Tamed

Timing of simulator exercises seems to be critical from an operational point of view. We discovered that 2 hours seem to be the maximum length of time the machine can be run. This is not because of limitations of operators but because of heat build-up. After 2 hours of operation, the thermostat opens the circuits to the lamps, and except for the fans, the entire unit shuts down.

To avoid surprise shutdowns every 2 hours, we turn off the lamps and give the trainees a 15-minute break. Meanwhile, we keep the clock running for the exercise. This lends realism to the exercise and provides necessary relief from various types of strain. We are now incorporating the 15-minute breaks in the scripts for all long exercises.

Audio Arrangements Made

Because we were confused when we first saw all the audio equipment, we decided to organize and store all of it in an orderly and safe arrangement. Using the basic concepts of a suggestion by Kenneth Quint of R-2, we built our own compact audio control chest. All components are installed so that only one external power source is needed. This is possible because all of the components are solid state and have low power requirements. We built in a circuit breaker and pilot light, which aids in protection of the system. (fig. 2).

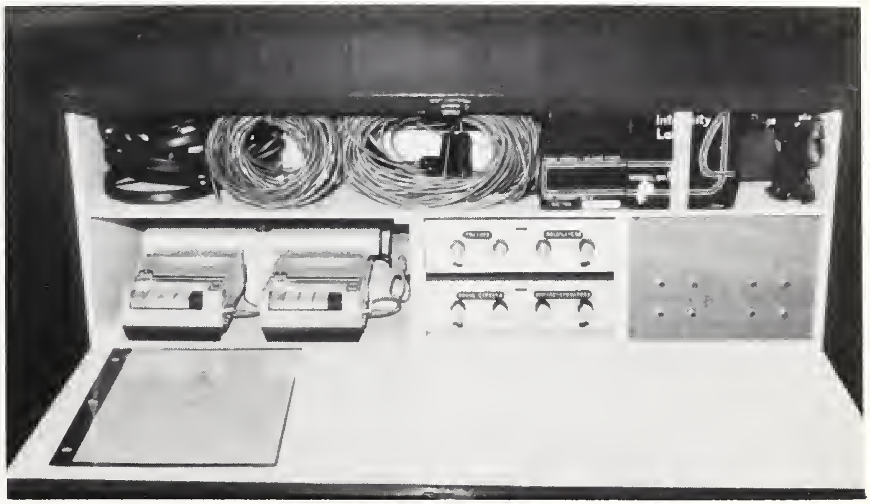
The rear projection screen assembly is bolted to the screen support legs. The bolts that came with the structure were hex head machine screws. We added wings to these to speed up the assembly of the screen by only hand tightening screws.

More Modifications

As we continue to use the Compact Fire Simulator, we find additional ways to smooth operations. All simulator personnel keep alert to better and faster ways to produce more realistic fire problems. This provides better training experiences for the trainees—which is what we're striving for.

What are your experiences with the Compact Simulator? We welcome your comments. Send them to *Fire Management*, Division of Fire Mgmt., Forest Service USDA, Washington, D. C. 20250. (The Oct. 1972, 5100 "Equip Tips" describing parts, source of supply, and purpose of the Compact Simulator is available upon request.)

Figure 2. Audio equipment chest has front and back storage compartments.



Rubin R. Atwood, Snoqualmie NF, sent in the basic design and concept for this "Wanted" poster as an employee suggestion. He also suggested the use of the "old West" style.

It is a forceful, attractive poster in keeping with efforts to make posters more interesting and to improve their message retention by the public.

This poster, No. P51-47, is stocked in Central Supply and will be placed on the approved list of standard posters in the Forest Service Sign Handbook.